We believe that in our opposition to the project there is also the opposition of ground-disturbing activities. So we would suggest that any activities that are proposed regardless of nature always consider what has the least disturbance to the land. As such there is under the long term -- I'm sorry -- the high heat mode I believe is what it's called. I'm trying to get the term. I'm sorry. The higher temperature repository operating mode.

In looking at those various options, there is one that -- one of the options would consider least disturbance to the ground and that's what we would be proposing.

Response
Thank you for your comment. DOE will continue to evaluate design features and operating modes that would reduce uncertainties or improve long-term performance and improve operational safety and efficiency. Design features will continue to evolve in response to additional as described in Section 4.1.1.2 of the EIS the higher-temperature operating mode would disturb less land than the lower-temperature operating mode.

7.5.1 (13361)
Comment - 010182 / 0009
Land Area -- Expanding the capability of the Waste Handling Building to use for blending hotter and cooler waste packages, and surface aging; adding flexibility to include subsurface design to enable a cooler repository, including increased ventilation; adding a solar power generating facility to reduce the need for power from off the site; revising the emplacement drift layout to include increasing spacing between emplacement drifts to allow a moisture pathway between drift, and providing access to roads, all contribute to a much larger repository design than was originally estimated (and which an associated design and controls were set to "minimize impacts to drainage channels, potential for increased erosion and impacts from flash flooding" -- SDEIS, p3-7, para 3.1.3.2). Will this be a never-ending process? The DOE has expanded the land area which will be disturbed, but, the SDEIS provides no analysis of the additional disturbed land. The DOE assumes all land in the Yucca Mountain area is the same in terms of topography.

Response
Section 3.1.3.2 of the Supplement to the Draft EIS discusses the land area that would be disturbed if either a higher-temperature operating mode or lower-temperature operating mode for the flexible design was implemented. This information was carried forward to the Final EIS. The Supplement focused on the primary impact indicators, the most important contributors or parameters used to determine the impacts in a particular environmental resource area. These primary impact indicators are identified in Table 3-1 of the Supplement and compared to those quantified in the Draft EIS. Subsequent sections of Chapter 3 discuss the primary impact indicators by environmental resource area. For example, Section 3.1.5 of the Supplement discusses potential impacts to cultural resources and acknowledges that impacts to cultural resources could occur in areas where ground-disturbing activities would take place including the construction of a surface aging facility, the solar power generating facility, and access roads and transmission cables. If important cultural resources are present in or adjacent to the areas to be disturbed by construction activities, DOE would undertake appropriate mitigative actions plan to reduce adverse effects to the resources.

7.5.2 AIR QUALITY/CLIMATE

7.5.2 (383)
Comment - EIS000048 / 0003
The surrounding areas have no protection from particulates vented from the repository.

Response
The impacts of particulate and gaseous releases from naturally occurring radon-222 at the proposed repository were analyzed in the EIS. Normal activities during construction, operation and monitoring, and closure would release small amounts of naturally occurring radon-222 (a noble gas) and its decay products from the subsurface. DOE examined the potential health impacts to members of the public from exposure to radon-222 and its decay products released from the repository. Section 4.1.2 of the EIS discusses the estimated radiation doses to maximally exposed individuals and populations from subsurface radon-222 releases. Section 4.1.7 describes short-term health and safety impacts to workers (occupational impacts) and to members of the public. DOE estimated that the maximally exposed individual would have no more than a 0.000031 (3.1 in 100,000) probability of a latent cancer fatality over

a 70-year lifetime from construction, operation and monitoring, and closure of the repository. Over the 115 to 341-year duration of project operations, the population within 80 kilometers (50 miles) of Yucca Mountain would have an estimated 0.46 to 2.0 latent cancer fatalities.

Tables 4-36 and 4-37 summarize of the EIS the impacts of a range of potential accidents that could occur during repository operations and result in a dose to the maximally exposed individual in for different meteorological conditions. These results show that this individual would have a likelihood of 0.000019 (1.9 chances in 100,000) of incurring a latent cancer fatality.

7.5.2 (601)
Comment - EIS000127 / 0018
Rainfall. This thing says we get about four to ten inches of rain a year. That might be true. How many remember getting four inches of rain in one morning this year? And that storm swept straight north to Yucca Mountain.

Response
Section 3.1.2.2 of the EIS discusses the average precipitation at the Yucca Mountain region, which ranges from 10 to 25 centimeters (4 to 10 inches) per year. DOE believes this is an accurate representation of the long-term annual precipitation range for the region. In relation to unusually heavy rainfalls, Section 3.1.2.2 also discusses the occasional periods of monsoon thunderstorms. Such storms can produce more than 2.5 centimeters (1 inch) of rain in a matter of hours. Two storms in mid-July 1999 produced 8.4 centimeters (3.3 inches) of precipitation in the Yucca Mountain site area. The maximum 1-hour amount during that month was 3.15 centimeters (1.24 inches). However, such occasional heavy rainfalls would not cause a deviation from the long-term prediction of precipitation at the site. Global climate change is addressed in the Total System Performance Assessment in Appendix I.2.1.

Section 3.1.4.1.2 of the EIS discusses the flood potential at Yucca Mountain. DOE used the probable maximum flood values to predict the areal extent of flooding and to determine if facilities and operations would be at risk of flood damage. The results of this analysis showed that flood levels would not reach either the North or South Portal openings to the subsurface facilities. Flooding was also considered as an accident-initiating event in Section H.2.1.3.

Section 3.1.4.2.2 of the EIS discusses groundwater at the Yucca Mountain site and acknowledges the variability of infiltration rates with time and location because of the sporadic nature of storms in the region. In addition, the EIS evaluates potential changes in climate over time to provide a range of conditions that determine how much water could fall onto and infiltrate the ground surface. Section I.2.2 discusses the future climate scenarios evaluated in the EIS long-term performance assessment.

7.5.2 (796)
Comment - EIS000197 / 0003
You have a discussion of radionuclide releases of radon 222 through the ventilation system during construction. Wouldn't you install the special filters used in power plants to filter the radioactivity out of the air? We feel that this is necessary to protect people that are downwind. In this part of Nevada where wind blows in any direction, we could be downwind from the proposed repository site.

Response
Radon-222 removal would not be practical because it is a noble gas and would pass through any filter. The estimated potential radiation doses to the public from naturally occurring radon-222 and its decay products due to repository-related operations would be very small, with the highest annual exposure estimated at 1.3 millirem per year. For comparison, the average person in the United States and the people in the Amargosa Valley near the Yucca Mountain site are exposed to approximately 200 millirem per year from naturally occurring radon-222 and its decay products (see Table 3-30 of the Final EIS). Since the publication of the Draft EIS, the Environmental Protection Agency promulgated *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada* (40 CFR Part 197), which included an annual dose limit to a member of the public of 15 millirem (40 CFR 197.4). In accordance with requirements of the Energy Policy Act, the Nuclear Regulatory Commission subsequently promulgated Yucca Mountain licensing criteria, which includes a Preclosure Public Health and Environmental Standard at 10 CFR 63.204 of 15 millirem per year to a member of the public. The appropriate sections of the EIS (including those mentioned in Chapter 8) have been updated to reflect a comparison to the

recently promulgated standard of 15 millirem. Because the potential dose from radon-222 emissions during repository operations would be so low and below relevant standards, installing additional equipment or processes to further reduce radon-222 gaseous emissions would not be warranted.

The special filters used for nuclear powerplants are for very limited, short-term applications or are effective only for specific radionuclides. They would not be effective for repository applications. For example, high-efficiency particulate air filters are effective in clean-air applications, but not where significant dust loading on the filter could occur, as it could at the proposed repository. In addition, filtering is not an effective method for reducing atmospheric releases of the naturally occurring radon-222 and its decay products because radon-222 is a gas and not a solid particle.

7.5.2 (971)
Comment - EIS000023 / 0003
Our region [southern California] may further be affected if the Yucca Mountain facility fails in its mission to secure highly toxic waste for 10,000 years. Santa Ana winds regularly drive Great Basin air into our region.

Response
The consequences of air release are inversely related to the distance from the release point; that is, for a given release, the consequences are less the farther one is from the release point. Section 4.1.7.5.3 of the EIS discusses the maximum impacts from a release during construction, operation and monitoring and closure phases of the proposed repository. Table 4-35 indicates that the dose to the maximally exposed individual would be less than 62 millirem over the 70-year lifetime of exposure, with a corresponding probability of latent cancer fatality being less than 0.000031. The highest annual dose to a member of the public from repository operations would be about 1.5 millirem or less. This dose is less than the applicable standards. Because southern California is approximately 100 kilometers (60 miles) south of Yucca Mountain, atmospheric dispersion would result in an even smaller radiation dose to that area.

Sections 5.5 and I.7 of the EIS discuss the potential consequences from release of radionuclides from the repository into the atmosphere following closure. There is limited potential for release to air because the waste would be isolated far below the Earth's surface. The EIS determined that radon-222 is the substance with the greatest potential impact from a release to air during the postclosure period. An estimated maximum annual release rate of about one-tenth of a microcurie would occur during about 19,000 years after repository closure. The estimated human health impacts to the population within 80 kilometers (50 miles) of the repository would be negligible, with no latent cancer fatalities expected. The reasonably maximally exposed individual would have very small risk of latent cancer fatality over a 70-year lifetime, about 0.00000000001. Potential impacts to individuals in southern California-would be even smaller than those for the region around Yucca Mountain because of their distance from the Yucca Mountain site.

7.5.2 (1374)
Comment - EIS000432 / 0002
The Hanford site caused many problems and I think the potential hazards would be even greater in storing the entire countries radioactive waste. Not just these farmers or residents are in potentially hazardous area, the animals and environment as well is at risk. It took a Federal courts appeal to change the air quality standards set by the new U.S. Environment Protection Agency National Ambient Air Quality Standard for the DOE to be able to operate its proposed site.

Response
The EIS analyzes the hazards of radionuclide releases from the Yucca Mountain site. Chapter 4 analyzes the impacts of repository operations and Chapter 5 analyzes the impacts of repository long-term performance. The potential doses to reasonably maximally exposed individuals would be small (see Sections 4.1.2, 4.1.7, and 5.4). At these levels the repository would meet all Federal regulations, and would be unlikely to result in any adverse health consequences.

The proposed repository would operate under and comply with stringent Federal regulations that are specific to the Yucca Mountain site, and under National and State of Nevada environmental protection requirements that could apply to a repository at Yucca Mountain. Chapter 11 of the EIS describes the statutory and other applicable

requirements that could apply to the Proposed Action. Section 11.2.7 discusses these environmental protection requirements, which include those applicable to animals. The type and quantity of radionuclides released to the environment as a result of the Yucca Mountain Repository and the regulatory requirements would be substantially different from those that applied at the Hanford Site.

7.5.2 (2007)
Comment - EIS000535 / 0001
I am vehemently opposed to being downwind of a radioactive dump site--not another one! When the Santa Ana winds blow out of the east, over the San Bernardino County area in Southern California, that puts me and many others downwind of wind-carried radiation from such dumps.

Response
The proposed Yucca Mountain Repository would be a highly engineered, state-of-the-art deep geologic disposal facility, designed specifically for safe, long-term disposal of spent nuclear fuel and high-level radioactive waste.

The consequences of air releases are inversely related to the distance from the release point; that is, for a given release, the consequences are less the farther the location from the release point. Section 4.1.2 of the EIS discusses releases of radionuclides during operations. The dose to the maximally exposed individual, someone living continuously at the southern boundary of the Land Withdrawal Area would be 1.3 millirem or less during the year of highest exposure. This dose would be mainly from naturally occurring radon-222 and its decay products. For comparison, Table 3-30 lists annual doses from natural background radiation to a resident of Amargosa Valley and at other locations, which are in the range of 300 millirem per year (200 of which is from radon).

Because the nearest point in San Bernardino County is about 120 kilometers (75 miles) south of Yucca Mountain, the potential radiation dose there would be even smaller than the 1.8 millirem calculated for the maximally exposed individual because of atmospheric dispersion over the additional distance. The concentration of radionuclides from potential releases at the Yucca Mountain site would be undetectable.

7.5.2 (3313)
Comment - EIS001085 / 0003
Radon monitoring data in the ESF [Exploratory Studies Facility] under current operating condition was used to estimate the amount of radon release from the site and the potential inhalation dose to workers. Since radon release from rock surfaces depends on various environmental and operational conditions of the MGR [monitored geologic repository] and since MGR operation would be different from the current ESF conditions, these release estimates should be reassessed in the FEIS. The effect of ventilation induced radon release due to pressure differences, the effect of heating of the rocks by waste packages, and other physical and environmental factors on radon release should be re-evaluated and included in the final assessment. All these factors could substantially increase the radon releases as well as the worker inhalation doses.

Response
The analysis of potential doses from exposure to radon and its decay products in the Final EIS used updated radon monitoring data from the Exploratory Studies Facility, updated design parameters and operational conditions as appropriate, and updated calculations. The analysis considered the effects of changes in ventilation rate, barometric pressure, and temperature. An updated Yucca Mountain report uses this information to model radon emanation and radon release from the repository under operating conditions of the flexible design operating modes. Section G.2.3 discusses this new information.

7.5.2 (5471)
Comment - EIS001887 / 0153
Page 3-12; Section 3.1.2.1 -- Air Quality

Were data collected since 1995 on air quality? If so, why wasn't it presented here? If not, why not?

Response
The gaseous criteria pollutant monitoring program ran from October 1991 through September 1995. It was discontinued because the baseline near-zero values of most pollutants were well established during the 4-year

program. Since then, only minor additional sources of gaseous pollutants have been added at Yucca Mountain. The analyses in Sections 4.1.2 and G.1 of the EIS confirm there would be minor releases of gaseous criteria pollutants -- concentrations at the location of the maximally exposed individual would be less than 1 percent or less of applicable National Ambient Air Quality Standards in every case. The particulate matter (as PM_{10}) monitoring program began in 1989, and continues to operate. The results of both the PM_{10} (through 1997) and the gaseous monitoring programs were presented in the *Environmental Baseline File for Meteorology and Air Quality* (DIRS 102877-CRWMS M&O 1999). The results of post-1995 air-quality monitoring required for compliance with the Air Quality Operating Permit (issued to DOE by the State of Nevada for site characterization) are discussed in the annual Site Environmental Reports from 1991 through 2000. These reports are available for review in DOE reading rooms or at the following Internet site: *http://www.ymp.gov* (search "Site Environmental Report").

7.5.2 (5589)
Comment - EIS001887 / 0214
Page 4-6; Section 4.1.2 - Impacts to Air Quality

This section uses the boundary of the proposed land withdrawal area as the basis for calculation of impacts to the maximally exposed member of the public. The proposed land withdrawal area is extraordinarily large compared to the repository operations area. This provides a large dilution factor for air quality analyses. The impact calculations in this section should be provided for the boundary of the operations area, rather than a distance of nearly 20 km from the operations area. This comment applies to all relevant analyses provided in Section 4. It also applies to Section 4.1.8.1, Radiological Accidents, where the maximally exposed offsite individual is placed 11 km west of the repository surface facility. In all cases, the maximally exposed offsite individual should have the characteristics of a subsistence farmer.

Response
DOE would exercise active control over portions of the land withdrawal area to prevent uncontrolled access by members of the public during the construction, operation and monitoring, and closure phases and any additional period of administrative control. Therefore, the Department used this boundary to calculate impacts to the reasonably maximally exposed individual. DOE would have to show that potential operational and accidental releases would be within Environmental Protection Agency regulatory limits. During the operation and monitoring phase of the Proposed Action, the most important release pathway would be the air pathway and the most important pathways for human exposure to airborne releases would be direct external radiation and ingestion of food and soil (40 CFR Part 197). The analysis considered all exposure pathways, including inhalation, ingestion, and direct external radiation from radionuclides in the air and on the ground. Based on published screening dose factors, direct external radiation from radionuclides deposited on the ground would account for about 40 percent of the dose; ingestion of decay products in foodstuffs and inadvertently consumed soil would account for 60 percent of the dose. Inhalation and external irradiation from radionuclides in the air would be minor exposure pathways.

7.5.2 (5593)
Comment - EIS001887 / 0218
Page 4-10; Section 4.1.2.2.2 - Radiological Impacts to Air Quality from Construction

The Draft EIS should be consistent in its use of millirem and person-rem. The definition of person-rem should be given here, not later in the Section.

This section has inconsistencies in reporting dose. This section reports the dose for the maximum exposed individual offsite for a five-year period and the dose of a maximally exposed non-involved worker as an annual dose. This appears to have been done to keep the numbers for the worker low.

Response
DOE believes it has used the terms "millirem" and "person-rem" consistently throughout this section and the EIS. Individual doses are calculated in millirem and population doses are calculated in person-rem. Section 3.1.8.1 of the EIS explains this concept.

Section 4.1.2 of the EIS presents both annual and total doses for repository operating mode and project phases. It reports these results for the maximally exposed member of the public and noninvolved worker, general population

within 80 kilometers (50 miles) and noninvolved worker population, and the Nevada Test Site noninvolved worker population.

Chapter 14 of the EIS contains definitions of these of both terms.

7.5.2 (5594)
Comment - EIS001887 / 0219
Page 4-11; Section 4.1.2.3.1 - Nonradiological Impacts to Air Quality from Continuing Construction, and Operation and Monitoring

What analysis supports the value of 10 micrograms per cubic meter used as the concentration for cristobalite?

Response
There is no public exposure limit for cristobalite. Sections G.1 and F.1 of the EIS describe the basis for selecting the 10-microgram-per-cubic-meter value for comparing exposure concentrations. An Environmental Protection Agency health assessment (EPA 1992) states that the risk of silicosis is less than 1 percent for a cumulative exposure of 1,000 (micrograms per cubic meter) × years. Assuming a 70-year lifetime, the EIS analysis established an approximate annual average concentration of 10 micrograms per cubic meter as a benchmark for comparison. Footnote "d" to Tables 4-1, 4-3, and 4-6 summarizes the estimated maximum criteria pollutant and cristobalite concentrations at the analyzed land withdrawal area boundary during different phases of repository construction, operation and monitoring, and closure.

7.5.2 (5595)
Comment - EIS001887 / 0220
Page 4-13; Section 4.1.2.3.2 - Radiological Impacts to Air Quality from Continuing Construction, and Operation and Monitoring

Define and quantify "very small" releases of other noble gases.
Were any analyses performed for accident scenarios for this section?

Response
As noted in Section 4.1.2.3.2 of the EIS, the main noble gas radionuclide release to the atmosphere from the handling of spent nuclear fuel assemblies would be krypton-85. Approximately 2,600 curies would be released annually. Estimated annual releases of other noble gas radionuclides would be about 1.0×10^{-6} curie of krypton-81, 3.3×10^{-5} curie of radon-219, 5.9×10^{-2} curie of radon-220, 4.6×10^{-6} curie of radon-222, and very small quantities of xenon-127." The amount of xenon-127 would be smaller than the smallest quantified radionuclide release (4.6 microcuries per year of radon-222).

Appendix H of the EIS describes potential repository accident scenarios, which include scenarios during the construction and operation and monitoring phases, such as accidents at the Waste Handling Building and mishaps that could occur during handling of the transportation casks at the repository.

7.5.2 (6504)
Comment - EIS001632 / 0038
Page 4-30, Section 4.1.4.2: This section states that "routine releases of radioactive materials from the repository would consist of radioactive noble gases, principally isotopes of krypton and radon." Does DOE have any examples of where these types of releases are currently occurring? If so, are they monitored and have there been any impacts to biologic communities?

Response
Section G.2.3.2 of the EIS discusses releases of noble gases from spent nuclear fuel in repository surface facilities in more detail. Releases of noble gas radionuclides could occur at any commercial nuclear reactor sites that handle spent nuclear fuel. Such releases are documented in annual and semiannual environmental reports and published in a Nuclear Regulatory Commission summary, *Radioactive Materials Released from Nuclear Power Plants* (DIRS 155108-Tichler, Doty, and Lucadamo 1995).

Krypton and other noble gases do not accumulate in environmental or biological media and, therefore, present little hazard to humans or the environment. Radon is somewhat different because of its decay products, but so little radon is released from spent nuclear fuel that it is almost immediately indistinguishable from naturally occurring radon in the environment. As stated in Section 4.1.4.2 of the EIS, estimated doses to plants and animals would be small and impacts from those doses would be unlikely to affect the population of any species because the doses would be much lower than 100-millirad-per-day. The International Atomic Energy Agency has stated that there is no convincing evidence that chronic exposures of 100 milliard per day will harm plant or animal populations. Neither of these noble gases is typically monitored in biologic communities because the potential for impact is so small.

7.5.2 (6663)
Comment - EIS001878 / 0041
Impacts on air quality not adequately addressed. Because the analysis of air quality impacts focuses only on pollutant concentrations at the boundary of the land withdrawal area, the DEIS does not adequately address possible air pollution impacts on Clark County and other areas (pp. 4-6, -7, -102). The DEIS must disclose whether the bulk emissions documented in Appendix G would aggravate existing air quality problems in Clark County and elsewhere. According to newspaper reports in January 2000, Clark County may soon face federal sanctions regarding funding of new transportation projects as a result of continuing problems attaining state and federal air quality standards.

The DEIS must also disclose the predicted downwind concentrations of radiological and nonradiological air pollutants, and the maximum distance at which measurable concentrations could be detected. Eureka County needs to know whether airborne emissions from the repository could be carried to Eureka County and neighboring counties, as they were during nuclear weapons testing in the 1950s and 1960s.

Response
Chapter 6 of the EIS discusses the impacts of the various transportation alternatives. Sections 6.3.2 and 6.3.3 discuss the rail and heavy-haul truck alternatives respectively, including those that would affect Clark County. The EIS notes that the Las Vegas basin airshed is in nonattainment for particulate matter (PM_{10}) and carbon monoxide. The EIS estimates potential air quality impacts from repository construction and operation if a decision was made to implement both rail and heavy-haul truck transportation scenarios.

The EIS presents information on predicted downwind concentrations of nonradiological air constituents and of the dose impact of downwind concentrations of radiological releases. Analyses were at the land withdrawal boundary, because these are the points where the impacts to the public could be the highest.

The predicted concentrations of nonradiological constituents are presented in Section 4.1.2 of the EIS and summarized in Tables 4-1, 4-3, and 4-6. These tables list the maximum concentrations of the criteria pollutants or cristobalite at the accessible land withdrawal boundary regardless of the direction. The projected concentrations would be small fractions of the regulatory limits established to ensure public safety (also listed in the tables). Because Clark and Eureka Counties are farther away, potential impacts from repository activities in these areas would be even smaller. Appendix G describes the methods DOE used to analyze potential impacts to air quality at the proposed Yucca Mountain Repository from releases of nonradiological air pollutants during the construction, operation and monitoring, and closure phases. The bulk emissions in Appendix G were used to calculate the concentrations presented in Chapter 4.

The analysis did not present radiological air pollutant concentrations because they are an intermediate step in the calculation of radiation dose; regulations for exposure to ionizing radiation are presented in units of radiation dose. The radiological doses to the public are summarized in Tables 4-2, 4-4, 4-5, and 4-7. The maximum distance at which radionuclides released from Yucca Mountain could be detected would be highly variable, depending on meteorological conditions. However, it would be very unlikely that radionuclides released from repository operations could be detected or distinguished from natural background outside the 80-kilometer (50-mile) area included in population calculations (all of Eureka County is beyond 80 kilometers).

It is difficult to compare potential releases from the proposed repository at the Yucca Mountain site meaningfully to those that from the above-ground testing conducted during the 1950s and 1960s because of the extreme differences in the quantity and method of radionuclide release. Potential releases for the Yucca Mountain site would be a very small fraction of those from above-ground testing.

7.5.2 (7210)
Comment - EIS001337 / 0089
Page 3-10 Section 3.2. 1. The text should make clear why an 80 km radius was selected around the Yucca Mountain site for air quality impact analysis. Given wind patterns is a consistent radius appropriate for determining potential impacts.

Page 3-12 Section 3.1.2.2. The choice of 60 meters as a maximum for wind measurements (see Figure 3-3) may not be appropriate to determine potential for dispersion under conditions of volcanism. If wind velocities at greater heights were used for atmospheric dispersion modeling, such differing heights should be identified here. This section would also benefit from a table showing dispersion times from the site to community areas offsite (in all directions). The table should indicate how long dispersion from the site would take to reach communities located in all counties surrounding Yucca Mountain.

Response
Eighty kilometers (50 miles) is the long-established precedent for calculating the potential population (collective) dose around a nuclear facility (dating back to 1975). The National Council on Radiation Protection and Measurements Report *Principles and Application of Collective Dose in Radiation Protection* (DIRS 101858-NCRP 1995) contains a brief history of the development of the 80-kilometer application (DIRS 101858-NCRP 1995).

Section 3.1.2.2 of the EIS provides background information on the meteorology of the potentially affected environment around Yucca Mountain. Figure 3-3 shows wind direction and wind speed based on past measurements that can be used in analyzing ground level or stack releases. Appendix G discusses meteorological data and atmospheric dispersion factors. Different meteorological information might be needed to adequately evaluate the potential impacts of volcanic events, depending on the type of event assumed to occur. Disruptive events, including potential volcanic disturbances, are discussed in Section 5.7.2. The ash dispersal model used information on eruption characteristics, wind direction, and velocity, and ash and waste characteristics. The potential impacts of such events or accidents are typically evaluated at the location of the most highly exposed individual and in the direction that would result in the highest exposure to the population. Because volcanic events have extremely low probabilities (estimated at less than 1 in 100 million per year), their associated risk is also very low.

7.5.2 (7227)
Comment - EIS001337 / 0105
Page 4-9 Radiological Impacts to Air Quality from Construction - The DEIS discusses the potential of radionuclide releases of radon-222 through the ventilation system. To provide protection to the people that are down wind from the site, DOE should install adequate filters to remove the radioactive particles from any exhaust release.

Response
Radon-222 removal would not be practical because it is a noble gas and would pass through any filter. The estimated potential radiation doses to the public from naturally occurring radon-222 and its decay products due to repository-related operations would be very small, with the highest annual exposure estimated at 1.3 millirem per year. For comparison, the average person in the United States and people in the Amargosa Valley near the Yucca Mountain site are exposed to approximately 200 millirem per year from naturally occurring radon-222 and its decay products (see Table 3-30 of the EIS). Since publication of the Draft EIS, the Environmental Protection Agency promulgated *Public Health and Environmental Radiation Protection Standards for Yucca Mountain, Nevada,* at 40 CFR Part 197, which included an annual dose limit to a member of the public of 15 millirem (40 CFR 197.4). In accordance with requirements of the Energy Policy Act, the Nuclear Regulatory Commission subsequently promulgated Yucca Mountain licensing criteria, which includes a Preclosure Public Health and Environmental Standard at 10 CFR 63.204 of 15 millirem per year to a member of the public. The appropriate sections of the EIS (including those mentioned in Chapter 8) have been updated to reflect a comparison to the recently promulgated standard of 15 millirem. Because the potential dose from radon-222 emissions during repository operations would be so low and below relevant standards, it would neither be practical nor cost-effective to install additional equipment or processes to further reduce such emissions.

7.5.2 (7373)
Comment - EIS001957 / 0013
Section 3.1.2.2, Climate -- This section states that annual precipitation in the area ranges from approximately 4-10 inches. However, no analysis is accorded to potential changes in climate over the next 100-1,000-10,000 years. It is important to note that in the last 10,000 years, there have been substantial, documented changes in climate in this region, including periods of much wetter climate than at present. This significant factor must be assessed in the final EIS (likewise in Section 5, Environmental Consequences of Long-Term Repository Performance).

Response
DOE has revised Section 3.1.2.2 of the EIS to include a discussion of paleoclimatology. The primary assumption associated with paleoclimatology efforts is that climate is cyclical so past climates provide insight into future climates. The analysis group climate regimes believed to have existed in Yucca mountain's past, that, therefore, should occur in its future into four different categories: a warm and dry, modern-like interglacial climate; a warm and wet monsoon climate; an intermediate glacial transition climate; and glacial periods. Characteristics of these climate regimes and postulated future durations are included as input parameters to the long-term performance assessment modeling performed for the site. Section I.2.1 of the Final EIS describes the process considered in the Assessment, including future climate projections. The Total System Performance Assessment addressed global climate change using a climate model based on paleoclimatology information; that is, the record of climate changes in the past was used to predict the expected changes in climate for the future.

7.5.2 (7644)
Comment - EIS001928 / 0008
pg. S-35-6th para., last sentence -- "Releases would vary from 90 to 2,600 curies annually depending on the packaging scenario." That is quite a range. Please explain how those values were determined and which packaging scenario will release the most activity.

Response
The final dose rate would vary depending on the final waste form; that is, whether the spent nuclear fuel is received as a bare intact assembly, in sealed canisters that require being opened and repackaged, or whether the fuel is shipped in disposable canisters. Section A.1.1.3 of the EIS describes the final waste forms that could be received at the proposed repository. Section G.2.3.2 of the EIS discusses the unloading and handling of the fuel at the proposed repository. Uncanistered fuel and fuel in dual-purpose canisters would result in the highest annual releases. During handling, material transfers from shipping casks to disposal containers would allow noble gases to escape from the small percentage of fuel elements that had failed. In contrast, disposable canisters would not be opened during the transfer process. However, under the disposable canister option about 20 percent of the fuel would be uncanistered, accounting for the small amount of release.

7.5.2 (7894)
Comment - EIS001653 / 0048
Section 3.2.2.1.2 There is no climate description for Northern Nye and Lander Counties.

Response
The EIS provides a general climate description for those areas through which potential alignments in rail corridors could pass. These areas include northern Nye and Lander Counties. Since the U.S. Department of Transportation accident and vehicle fatality rate data (which include accident statistics for each state under the full range of climatic, road, and traffic conditions for the period from 1994 to 1996) were used to assess impacts, the effects of weather conditions in Nevada were considered in the EIS analysis. Section 3.2.2.1.2 has been modified to clarify DOE's approach.

7.5.2 (8081)
Comment - EIS001653 / 0061
Pg. 4-12 Section 4.1.2.3.2 Should the analysis consider a possible release scenario at the surface handling facility including the potential for and the consequences thereof?

Response
Appendix H of the EIS considers radiological and nonradiological repository accident scenarios including surface facilities. Section 4.1.8 of the EIS describes potential impacts of off-normal and accidental releases from the surface facilities. Section 4.1.2 considers routine releases.

7.5.2 (8284)
Comment - EIS000817 / 0102
P. 4-72. What is the amount of pollution from all the fossil fuel used to store and dispose of nuclear fuel? What are all the externalities here?

Response
Nonradiological air pollutants at the proposed repository would include nitrogen dioxide, sulfur dioxide, and particulate emissions from fossil fuel consumption. Appendix G of the EIS describes the quantities of pollutants released from various activities at the proposed repository. DOE analyzed potential impacts of such releases by comparing them to National Ambient Air Quality Standards at the location of the maximally exposed individual. Tables 4-1, 4-3, and 4-6 of the EIS summarize nonradiological impacts at the analyzed withdrawal area during different phases of repository operation and show that the concentrations of these constituents would be less than the applicable standards. Because the regulatory standards for comparison are promulgated as either a 1-hour, 3-hour, 8-hour, 24-hour or on an annual basis, the total quantity of pollutants generated over time was not calculated.

7.5.2 (8445)
Comment - EIS001397 / 0013
The Yucca Mountain site for this project was chosen in part for the desert conditions and low average rainfall in the region. However, the DEIS fails to address the fact that often [the] entire annual rainfall occurs in a very few severe storms with flash flood conditions. The addition of "raincoats" or drip shields to the casks does not sound like an adequate solution. The final EIS must address the many inches of rain that can occur in this region in a single hour.

Response
Section 3.1.2.2 of the EIS discusses the Yucca Mountain region average precipitation, which ranges from 10 to 25 centimeters (4 to 10 inches) per year. DOE believes this is an accurate representation of the long-term annual precipitation range for the region. Regarding unusually heavy rainfalls, Section 3.1.2.2 also discusses occasional periods of monsoon thunderstorms that can locally produce more than 2.5 centimeters (1 inch) of rain in a matter of hours. However, such occasional heavy rainfalls would not cause a deviation from the long-term prediction of precipitation at the site. The flash flood and rapid runoff conditions are of little concern because surface runoff by its very nature would not infiltrate the mountain, but would flow over and past the proposed repository. During the operational period, the subsurface portals would be protected from such flooding should it occur. After closure, these portals would be sealed and unavailable for water to enter.

The EIS evaluated climate change and its potential effect on long-term repository performance. Section I.2.2 of the EIS discusses the effects of future shifts to a cooler and wetter climate.

Since the publication of the Draft EIS, DOE has modified the repository design to include titanium drip shields over the waste packages. The drip shields would be placed over the waste packages immediately before closure. The function of the drip shields in the flexible design would not be related to heavy rainfall events; rather, their function would be to divert water that might seep into an emplacement drift. The Final EIS discusses these design changes and the steps DOE would take to close the repository.

7.5.2 (8827)
Comment - EIS000869 / 0008
Regarding S.4.1.2, referencing radiological and nonradiological impacts, the dust suppression techniques used during excavation, i.e., water spraying, could lead to faster and higher levels of water contamination. With the low humidity in the desert areas, it could also vaporize and increase air contamination.

Response
Water spraying is a common dust suppression technique. During the construction of the repository, DOE would spray water on disturbed soil and earth material excavated from the subsurface. This material would not be

contaminated, although one purpose of spraying water would be to limit the mobilization of dust containing the naturally occurring carcinogenic mineral cristobalite, which would be present in some excavated material. There would not be enough sprayed water used for dust suppression to infiltrate to the repository level. Evaporation of the water would not lead to additional air contamination.

7.5.2 (8841)
Comment - EIS000869 / 0014
There is no indication of the estimated number of thermal units to be released into the atmosphere and surrounding environment and what impact it may have on the climate and ecosystems of the area.

Response
DOE has expanded the issue of thermal management to the Final EIS. Exhaust ventilation heat is discussed in Chapter 2, and potential impacts are addressed in Section 4.1.2.3. The revised flexible design (EDA II without backfill) would remove at least 70 percent of the heat generated by the waste inventory during the preclosure period. The peak ventilation air temperature would be 58° Celsius (about 136° Fahrenheit) occurring 10 years into the preclosure period and decreasing thereafter. This is lower than the exhaust air temperature of many industrial processes, such as powerplants and manufacturing facilities. DOE expects no significant impacts from the heat released in ventilation air on either the climate or ecosystems of the area.

7.5.2 (8940)
Comment - EIS001922 / 0009
Air Quality

The DEIS does not adequately address the fact that the site will not meet the current Carbon 14 (C-14) emissions standard for waste facilities, nor does it examine the consequences of such releases.

Response
DOE expects negligible releases of carbon-14 during the repository operations and monitoring and closure phases. Section 5.5.2 of the EIS discusses potential long-term releases of carbon-14 to the atmosphere and the potential atmospheric consequences tot he local population and to an individual receptor. The results of this analysis shows that the dose to the public would be far below applicable dose limits. After DOE closed the repository, carbon-14 in the form of carbon dioxide would have a potential for gas transport.

7.5.2 (9729)
Comment - EIS001887 / 0221
Page 4-15; Section 4.1.2.3.2 - Radiological Impacts to Air Quality from Continuing Construction, and Operation and Monitoring

Define and quantify “minimal” and “very small.”

Response
DOE has clarified the discussion in Section 4.1.2.3.2 of the EIS of the radiological impacts to decontamination workers during the monitoring and maintenance phase. Essentially the only radioactive material released to ambient air during this phase would be naturally occurring radon gas vented from the subsurface. Because there are low levels of naturally occurring radioactivity and because DOE would use high-efficiency particulate air filters for air exhausted to the atmosphere, there would be negligible releases of airborne radioactivity other than radon. The collective dose to the nondecontamination period than during the remainder of the monitoring and maintenance phase because there would be more such workers during decontamination.

7.5.2 (11020)
Comment - EIS001896 / 0017
Section 4.1.2.2.2

There could be radiological impacts on air quality during construction of the facility.

Response
No releases of manmade radionuclides would occur during the construction phase of the proposed repository because such materials would not be present until the repository began operations. Section 4.1.2.2.2 of the EIS discusses potential radiological impacts during repository construction from naturally occurring radionuclides, primarily radon-222 and its decay products, released during construction of the subsurface facilities. Table 4-2 shows that the annual dose to the maximally exposed individual at the southern boundary of the Land Withdrawal Area would be about 0.5 millirem per year during the initial construction phase. This dose would be about 3 percent of the 15-millirem-per-year regulatory limit in 40 CFR 197.4 and 10 CFR 63.204.

7.5.2 (11367)
Comment - EIS002278 / 0004
I see no talk about global warming and the effects that the scientists are talking about now, and how within the next 50 years even, a hundred years, our climate change may be such that that whole mountain might be under water.

Response
Section 3.1.2.2 of the Final EIS includes a discussion of paleoclimatology. Climate regimes believe to have existed in Yucca Mountain's and, therefore, that should occur in the future have been grouped into four different categories, as described in Section 3.1.2.2. Characteristics of these climate regimes and postulated future durations are included as input parameters to the long-term performance assessment modeling for the site. Global climate changes are addressed in the Total System Performance Assessment in Appendix I.2.1, using a climate model based on paleoclimatology information. No credible scenario was identified that could result in Yucca Mountain being submerged under water.

7.5.2 (11705)
Comment - EIS001888 / 0383
[Clark County summary of a comment it has received from a member of the public.]

One commenter noted that the radiation risk to residents (Esmeralda County) of airborne exposure should be included in the EIS.

Response
Environmental impact statements have historically used an area within 80 kilometers (50 miles) for analyzing potential impacts from airborne radiation exposure because this is the established precedent for calculating the potential population (collective) dose around a nuclear facility (DIRS 101858-NCRP 1995). The small portion of Esmeralda County that lies within 80 kilometers (50 miles) of the proposed Yucca Mountain Repository is included in the EIS. As noted in Figure 3-25, about 20 persons in Esmeralda County (26 projected for 2035) live within this area. There would be no meaningful impacts to residents of Esmeralda County more than 80 kilometers away from the activities at Yucca Mountain.

7.5.2 (12404)
Comment - 010242 / 0022
Page 3-4: Section 3.1.2.1 - Radiological Air Quality
There is no basis to calculate radon beginning 20 km from the repository, the proposed boundary of the accessible environment for the repository, since the source of the radon is not the radioactive waste to which repository disposal performance regulations are intended to apply. The public exposure should be calculated at points nearest the source, outside the restricted operations area, since members of the public will frequent these areas and be exposed to the released radon.

Response
Radon emanates from the rock of the subsurface repository, enters the repository drifts, and is exhausted in ventilation air. For purposes of public exposure, the source of the radon is the ventilation shafts and exhaust ducts that would service the subsurface repository, since the radon is being released in the subsurface ventilation air. No members of the public would be routinely exposed within the proposed land withdrawal boundary, since this area would be off-limits to public access. If members of the public would enter this area, it would be for limited periods of time, and not for the continuous yearly exposure considered for people living outside the land withdrawal area. If members of the public do visit the Yucca Mountain operations areas they would be subject to DOE's radiation

protection limits and guidance. Any potential radiation exposure from radon or other sources would be of limited duration and any potential radiation dose would be expected to be very low.

7.5.3 HYDROLOGY/GEOLOGY

7.5.3 (1212)
Comment - EIS000322 / 0003
Besides the deadly threat of transportation of this high-level radioactive waste, the storage of the waste in Yucca Mountain also poses a threat to us all. Yucca Mountain is volcanic, it is seismically active, and it will leak. Studies have been done that indicate Yucca Mountain has been flooded with hot water in the past.

Response
Based on the results of analyses in Chapter 5 of the EIS on the long-term performance of the proposed repository at Yucca Mountain, DOE believes that a repository would operate safely (in compliance with the Environmental Protection Agency's Environmental Radiation Protection Standards in 40 CFR Part 197). Section 3.1.3 of the EIS describes the geologic setting of Yucca Mountain and the surrounding region in great detail, including faults, seismicity, and the volcanic history of the region. Section 4.1.8 of the EIS describes the potential impacts from accident scenarios associated with earthquakes during repository operations. Several sections in Chapter 5 consider earthquakes and volcanic eruptions and their effects on the long-term performance of the repository. DOE believes that the EIS adequately describes and analyzes geology, geologic hazards, and the effects of these hazards on the proposed repository.

Section 3.1.4.2.2 of the EIS describes evidence that the elevation of the water table at Yucca Mountain has fluctuated over time. These fluctuations have been due primarily to changes in the climate. DOE examined the cumulative effects on the elevation of the water table from a wetter climate, earthquakes, and a volcanic eruption. Based on the evidence, no reasonable combination of wetter climates, earthquakes, and volcanic eruptions could raise the elevation of the water table sufficiently to inundate the waste emplacement areas at Yucca Mountain.

There is no evidence to suggest that the water table at Yucca Mountain is slowly rising. Section 3.1.4.2.2 (Saturated Zone) discusses opposing views on fluctuations in the elevation of the water table. A small number of investigators believe that the water table has risen in the past to elevations higher than the waste-emplacement areas. DOE does not concur with these views, nor did an expert panel that the National Academy of Sciences convened to examine this issue (as described in Section 3.1.4.2.2). DOE believes that the geologic evidence strongly indicates that past water levels at Yucca Mountain have not been more than about 120 meters (390 feet) higher than present for the past several million years.

7.5.3 (1376)
Comment - EIS000432 / 0004
Furthermore, there is also surface and ground water that flows near the proposed site at Yucca Mountain. For example, the Fortymile Canyon river/waterway flows just east of Yucca Mountain itself. The Buckboard waterway flows from the north. The [Amargosa] River flowing from the west alongside Yucca Mountain down to the south of Yucca Mountain. The DOE also states that "In the distant future groundwater would contain small quantities of radionuclides and chemical toxic substances." (s-42) Again the DOE says that the impact on plants and animals would be small and "unlikely" to have adverse impacts.

Response
Section 3.1.4.1 of the EIS describes surface water in the area of Yucca Mountain in detail. The Amargosa River and its tributaries (including Fortymile Wash) are dry along most of their lengths most of the time. The Central Death Valley hydrologic subregion consists of three groundwater basins, each with smaller sections. Yucca Mountain is in the Alkali Flat-Furnace Creek groundwater basin. Hydrologic models derived from extensive studies indicate that water infiltrating at Yucca Mountain would join groundwater in the Fortymile Canyon section and flow toward the Amargosa River section (see Figure 3-13). Thus, the small fraction of water of the total in the basin that might move through a repository would be likely to flow toward the south toward Amargosa Valley. Long-term performance assessment (modeling) analyses indicate that the combination of the natural barriers of the repository site and engineered barriers would keep the radionuclides well below the regulatory limits established at 40 CFR Part 197. Sections 3.1.4.2.1 and 5.4 of the EIS contain more information.